Amend claim 15 to read:

C3

15. (Amended) A method according to claim 14 in which the product sulfur reduction catalyst comprises a USY zeolite having a UCS of from 2.420 to 2.455 nm, an alpha value of from 0.2 to 300 and a bulk silica:alumina ratio of at least 5.0 as the molecular sieve component and, as the metal component, vanadium in an oxidation state greater than zero selected from zinc or vanadium, the zeolite being in a matrix of alumina or silica-alumina with clay.

Cancel claims 20 to 27 and 32 through 35.

Remarks

1. This is in response to the Office Action of 24 April 2001.

2.1. Accompanying this response is an Information Disclosure Statement, submitted under 37 CFR 1.97(c)(2) with the appropriate fee, which identifies two references which are relevant to the examination of this application. U.S. 4,794,095 and 4,846,960 (both to Walker, assigned to Philips). The Walker references disclose the use of cracking catalysts which are based on pure silica matrix materials in which the active zeolite cracking component, e.g. zeolite Y, is embedded (column 1, lines 37-38). In addition to the silica matrix and the zeolite, the catalyst contains at least one vanadium oxide (column 1, lines 42-45) in an amount which has been found to be effective for alleviating the problem of deactivation by the presence of vanadium in the cracking feeds (column 1, lines 17-22). The patent stresses the importance of using a pure silica matrix material for the catalyst: see column 8, lines 42-50.

2.2. By contrast, the claims of the present application claims are directed to the use of vanadium-containing molecular sieves in matrices which are based on alumina or silica-alumina with added clay. Since the Walker references teach away from the use of matrices other than pure silica (see column 8, lines 42-50), it is believed - and it is so submitted - that the claims are patentable over the Walker references as well as those previously made of record.

3. Applicants note the Examiner's position regarding the election/restriction requirement. To conserve effort in these proceedings, Applicants have canceled the claims directed to the catalytic compositions and will not press their position further at this point, save only to note that if the Examiner's arguments were to be accepted, it might lead to the conclusion (which seems quite open to challenge) that the requirements of the MPEP, a set of internal guidelines for the use of an administrative agency, supercede the requirements of the law (Section 706 of the APA), as established by the Congress and enunciated by the Supreme Court. See, for example, *SEC v. Chenery*, 318 US 80, 89 to 93 (1943). Although Applicants do not categorize the Examiner's example in this way (or even to make any such implication), it is pointed out that an example unsupported by credible factual evidence appears to be no more than argument since the most fanciful example could be conceived and advanced without reference to credible fact or accepted theory. For this reason, the requirements of the act, passed by a benevolent and far-seeing Congress, and as interpreted by a wise and omniscient Supreme Court, should have prevailed.

4. The claims, especially independent claims 1 and 11, have been amended to specify that the metal component of the sulfur reduction catalyst comprises vanadium. This amendment resolves the rejection under 35 USC 112.

5.1. The Examiner has rejected claims 1-7, 10-14, 17-19 and 28-31 under 35 U.S.C. 103(a) as obvious over the disclosure in Collins, et al. U.S. 5,482,617.

5.2. As the Examiner has noted, Collins deals with a desulfurization process for a catalytically cracked feed stream which may be derived from an FCC process (Paper no. 5, page 6). In the Collins process, the low boiling range feed which contains organic sulfur compounds is contacted with a catalyst in a fixed fluidized bed at elevated temperatures in the range of 700 to 850°F (column 2, line 30-36; column 4, lines 4-5. The desulfurized product is a gasoline range material, as noted at column 5, line 2. The catalyst used in the Collins process is an acidic zeolite such as ZSM-5 (intermediate pore size), or zeolite Y or zeolite beta (both large pore size materials). These zeolites may be employed in their acid forms or iron exchanged or impregnated with one or more suitable metals including zinc, nickel, cobalt and metals of other groups of the Periodic Table (column 5, line 29-42). There is, however, no suggestion in Collins that vanadium might be used and for this reason, coupled with the fact

that there was a strong conviction in the art (cf. the Wormsbecher references of record) that the presence of vanadium in FCC catalysts was very undesirable, it is submitted that the claims are patentable over Collins for this reason alone, regardless of the other distinctions previously set out in this record.

6. The second rejection, of claims 8, 9, 15 and 16, is under 35 USC 103(a) and is based on the Collins and Chu references. Chu is relied on, in addition to Collins, to support the proposition that the choices of alpha values and unit cell sizes for the molecular sieve (claims 8, 9, 15 and 16) are do not render these claims patentable. Applicant considers that these claims are patentable over the Collins and Chu teachings for the reasons advanced above with respect to Collins. In order to facilitate consideration of the real issues in this case, Applicant will not at the present time advance further arguments with respect to the rejection based on the combined Collins/Chu references but will rely upon the arguments set out above given with respect to Collins. The Examiner has noted (Office Action, page 7) that Collins does not disclose vanadium components in the catalyst.

7.1. Claims 32 to 35 have been rejected under 35 USC 103(a) in view of Collins, in view of Kim, U.S. 5,407,878.

7.2. Kim discloses, as the Examiner has noted, a composition that may be used to control emissions of sulfur oxides formed during the oxidative regeneration of FCC catalysts as well as controlling the adverse effects of nickel or vanadium encountered in FCC operations. The composition described in Kim as a SOx gettering agent/metals passivaing composition, comprises a ternary oxide composition of magnesium, lanthanum and aluminum oxides in certain specified proportions. This is combined with catalytic oxidation and/or reducing promoters such as the oxides of cerium, vamadium, iron and/or titanium (column 2, lines 12-18). There is no suggestion that the Kim ternary oxide composition may or should contain a molecular sieve component although sieve materials (zeolites) are, of course, included in the FCC cracking catalyst which is blended with the Kim materials (column 3, lines 32-39; claim 8). For this reason, there is nothing in Kim which discloses or suggests that vanadium might be present in the form required by the present claims, namely, in an oxidation state greater than zero in the interior pore structure of a molecular sieve component of a catalytic material.

7.3. The Examiner has stated that it would have been obvious to include vanadium and/or iron in the "disclosed catalyst" (assumed, of Collins) because the Kim reference illustrates that iron and/or vanadium is known to control SOx emissions during oxidative regeneration. This conclusion does not appear to flow legitimately or logically from what is disclosed in these two references. Kim discloses only that iron and/or vanadium are effective for controlling sulfur oxide emissions during the oxidative regeneration of FCC catalysts when these promoters (or others) are combined in the ternary oxide compositions described by Kim. There is no suggestion that the use of vanadium and/or iron is of general applicability for this purpose. For this reason alone, the inclusion of vanadium in the compositions of Collins which are not ternary magnesium, lanthanum, titanium oxide based, would not have been an expedient to which the appropriately skilled person would have made obvious resort. Second, even if Kim could be interpreted to suggest the desirability of including vanadium and/or in the Collins catalysts, the question then arises how and in what manner is it to be incorporated?. Shall it be by impregnation onto the matrix? This would appear to be the manner which might be closest to the technique used by Kim (which uses an oxide similar to a matrix material). But if so, this is not what is claimed by the present application, which requires that the vanadium is to be incorporated in a valence state above zero within the interior pore structure of the sieve component. Nothing in Kim suggests this feature and there is no reason of record why such a mode of incorporation would have been selected by the skilled person. The present claims are therefore patentable over the adduced combination of Collins and Kim.

8.1. Claims 1-4, 10 and 29 have been rejected as unpatentable under 35 USC 102(b) or alternatively, 35 USC 103(a), in view of Blanton U.S. 4,115,249.

8.2. Blanton discloses a technique for the removal of sulfur oxides from FCC stack gases using a catalyst composition produced by impregnating aluminum into the particles of the cracking catalyst, for example, a zeolite-containing silica-alumina cracking catalyst (column 8, lines 52-55 and 60-62; column 11, line 15). In addition to the aluminum which is added to remove the sulfur oxides from the regenerator gases, it is stated that various promoters may be added to the catalyst after heat treating (column 8, lines 16-43). Promoter materials referred to here inlcude base metal promoters such as vanadium, copper, chromium, iron and uranium as well as noble metals such as platinum and palladium (column 8, lines 16-28). The reactions which these promoters are intended to promote is not explicitly stated in but in view

of the references to the noble metals, it would seem that they are intended to promote the oxidation of carbon monoxide to carbon dioxide. It is not stated that these "promoters" have or would be expected to have any effect on the sulfur content of the liquid products.

8.3. Notwithstanding the reference to the use of vanadium as a promoter, it is submitted that the present claims are not anticipated by or rendered obvious by the Blanton disclosure. Although it is stated that the promoter metals may be added to the catalyst by "any known method" as by the use of organic or aqueous solutions of the metals (column 8, lines 36-42), it is not stated what form the vanadium is to be in these solutions. If it is in an organic solution, it will, of course, be impregnated as a non-ionic species and even if it did enter the pore structure of the zeolite, it would not be present in a valence state higher than zero, as required by the present claims. If aqueous solutions were to be used, again it is not stated in what form the vanadium is to be - cationic or anionic. In the case of a typical metal such as sodium, the matter would be beyond a peradventure of doubt but in the case of vanadium which is capable of forming anionic complex species as well as simple and complex cations, different possibilities arise and there is no unequivocal direction to use one form or the other. To be specific, vanadium may form aqueous solutions with cations such as simple vanadium or vanadyl or, alternatively, solutions of complex anions such as the various vanadate species from vanadium in various oxidation states, e.g. vanadium (IV) and vanadium (V), including vanadate, ortho-vanadate, pyro-vanadate and meta-vanadate. The use of such anionic vanadium species for the purpose of introducing vanadium into refining catalysts is well established, for example, in the manufacture of hydroprocessing catalysts.

8.4. Thus, it is neither expressly stated not implied in what form the vanadium should be in order to be added to the cracking catalyst. Certainly, it is not stated that the vanadium is to be in a form which will result in the metal being introduced into the interior pore structure of the sieve component of the catalyst in an oxidation state greater than zero. The case of anticipation under 35 USC 102(b) has therefore not been made.

8.5. As far as obviousness is concerned, it is pointed out that there is nothing in this reference which suggests that it would have been considered desirable to add the vanadium in a manner which results in it being present in the interior structure of the zeolite in an oxidation state greater than zero. Given that the purpose of the vanadium compoent in the Blanton

catalyst is most likely to promote CO oxidation, the form and oxidation state of the promoter metal is of no great moment - or, at least, none is stated. This would not have led the skilled catalyst formulator faced with the markedly different objective of reducing the sulfur content of the liquid cracking products, to introduce the vanadium by exchange into the interior pore structure of the zeolite in an oxidation state greater than zero.

8.6. Moreover, there is nothing in Blanton which can be taken to imply that his catalyst would be expected to possess product sulfur removal characteristics. Although the Examiner has stated that the Blanton catalysts would inherently function as "product reduction catalysts" (Office Action, page 9), and that the Blanton reference discloses the same process steps, the reference framework has been altered too much. While any - or almost any - catalytic cracking process results in sulfur removal from the useful hydrocarbon products simply because sulfur is converted to sulfur oxides in the regenerator, this is not the baseline case. The baseline case is the cracking process with a normal cracking catalyst (or some ineffective catalyst or additive material). The objective of the present invention is the production of liquid hydrocarbon products with a lower sulfur content than would have been achieved in the absence of the present materials whose effectiveness has been amply demonstrated - a true reduction in liquid product sulfur is achieved - see, especially the results reported in Table 10. This, be it noted is a reduction on top of whatever reduction is achieved by sulfur rejection to inorganic sinks such as sulfur oxides. For these reasons, given the differences in the nature of the material itself, the different purpose and the different nature of the problem, the present claims are not considered obvious in view of Blanton.

9. The next rejection is of claims 11-13, 17, 19, 28, 30 and 31 under 35 USC 103(a) as obvious over Blanton. Notwithstanding the similarities between the Blanton process as it might conventionally have been practiced and the presently claimed process and compositions, it is submitted that the differences are of greater significance. As previously pointed out, there is nothing in Blanton which points to the desirability of using vanadium exchanged into the interior pore structure of the zeolite component of the catalyst in an oxidation state greater than zero with the objective or, for that matter, any expectation, of reducing liquid product sulfur content. The differences set out above establish that the subject matter of these claims would not have been obvious to the skilled person having all due regard to the disclosure in Blanton.

10. Claims 5, 8, 9, 14, 15, 16 and 18 have been rejected under 35 USC 103(a) in view of Blanton and Chu. The same considerations apply here as in the preceding section: notwithstanding the similarities between the combined teachings of the references and those of the presently claimed invention, the differences are of greater significance. The differences set out above establish that the subject matter of these claims would not have been obvious to the skilled person having all due regard to the disclosure in these references. These claims are therfore considered patentable over the Blanton and Chu disclosures.

11. In view of the remarks and amendments set out above, reconsideration and withdrawal of the rejections is, where appropriate, requested.

Respectfully submitted,

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August 23, 2001

S rial No. 09/144,607
Amended Claims
Version marked to show changes

Amend claim 1 to read:

1. (Amended thrice) A method of reducing the sulfur content of a catalytically cracked petroleum fraction, which comprises catalytically cracking a petroleum feed fraction comprising a heavy hydrocarbon oil feed containing organosulfur compounds under catalytic cracking conditions of elevated temperature in the presence of a cracking catalyst and a product sulfur reduction catalyst which comprises a porous molecular sieve having a metal component which is within the interior pore structure of the molecular sieve and which comprises ~~a non-lanthanide base metal~~ vanadium in an oxidation state greater than zero in a matrix comprising alumina or silica-alumina with clay, to crack the heavy hydrocarbon feed to lighter liquid cracking products of reduced sulfur content.

Amend claim 11 to read:

11. (Amended thrice) In a fluid catalytic cracking process in which a heavy hydrocarbon oil feed comprising organosulfur compounds is catalytically cracked to lighter products by contact in a cyclic catalyst recirculation cracking process with a circulating fluidizable catalytic cracking catalyst inventory consisting of particles having a size ranging from about 20 to about 100 microns, comprising:
(i) catalytically cracking the heavy hydrocarbon oil feed in a catalytic cracking zone operating at catalytic cracking conditions of elevated temperature by contacting feed with a source of regenerated cracking catalyst to crack the heavy hydrocarbon oil feed to lighter products and produce a cracking zone effluent comprising lighter cracked products and spent catalyst containing coke and strippable hydrocarbons;
(ii) discharging and separating the effluent mixture into a cracked product rich vapor phase and a solids rich phase comprising spent catalyst;
(iii) removing the vapor phase as a product and fractionating the vapor to form liquid cracking products including gasoline,
(iv) stripping the solids rich spent catalyst phase to remove occluded hydrocarbons from the catalyst,

(v) transporting stripped catalyst from the stripper to a catalyst regenerator;

(vi) regenerating stripped catalyst by contact with oxygen containing gas to produce regenerated catalyst; and

(vii) recycling the regenerated catalyst to the cracking zone to contact further quantities of heavy hydrocarbon feed,

the improvement which comprises

reducing the sulfur content of a the gasoline portion of the liquid cracking products, by catalytically cracking the feed fraction at elevated temperature in the presence of a product sulfur reduction catalyst which comprises a porous molecular sieve having a metal component which is within the interior pore structure of the molecular sieve and which comprises ~~a non-lanthanide base metal~~ vanadium in an oxidation state greater than zero in a matrix comprising alumina or silica-alumina with clay, to produce liquid cracking products of reduced sulfur content.

Amend claim 15 to read:

15. (Amended) A method according to claim 14 in which the product sulfur reduction catalyst comprises a USY zeolite having a UCS of from 2.420 to 2.455 nm, an alpha value of from 0.2 to 300 and a bulk silica:alumina ratio of at least 5.0 as the molecular sieve component and, as the metal component, ~~a metal~~ vanadium in an oxidation state greater than zero selected from zinc or vanadium, the zeolite being in a matrix of alumina or silica-alumina with clay.